

Unit - 3Body Fluids and Blood

①

In average about the body fluid constitute between 55% - 60% of the total body mass.

Intracellular fluid (ICF) About two third of body fluid is ICF or cytosol the fluid within cell.

Extracellular fluid (ECF) About one-third of body fluid is ECF is outside cell and includes all other body fluids. ECF divided into interstitial fluid & Plasma.

● Blood :- Blood is a fluid connective tissue. It circulates continuously around the body, allowing constant communication between tissues distant from each other.

- The total volume of blood in the body is about 6 l.
- Blood is slightly alkaline with a pH of about 7.4
- The specific gravity of blood is about 1.055.

Function of blood :-

- It transports O_2 and nutrients to various tissues.
- It transports waste products to organs of excretion.
- It carries hormones from endocrine gland to various tissues.
- It redistribute water from one part of the body to other.
- It contains antibodies and white blood cells which protect the body from diseases.
- Clotting of blood protects against haemorrhage.

Composition of blood:- Blood contains a fluid called Plasma in which the cellular elements of blood are suspended.

Plasma:- Plasma contains:-

- 90-92% water.
- Proteins (Albumin, globulin & Fibrinogen)
- Other substances like glucose, sodium chloride. Serum is obtained from plasma after removing fibrinogen (Serum = Plasma - Fibrinogen)

Plasma Proteins: Plasma proteins occur in blood to the extent of 7-8%.

• Plasma proteins are:-

Albumin:- It is present in very high concentration. It is responsible for osmotic pressure of blood. It is synthesised in the liver.

Globulin:- It is of three type - α , β & γ . It is produced in lymphoid tissues, It produces antibodies and immune substances.

Fibrinogen:- It is responsible for coagulation of blood. It is synthesised in the liver.

Functions of Plasma Proteins:-

- They transport hormones, iron and other substances.
- They exert osmotic pressure and regulate blood volume.
- They provide viscosity to blood (which helps in maintaining B.P)
- Fibrinogen of plasma is necessary for clotting.
- Globulin of plasma is imp for the synthesis of immune substances called antibodies.

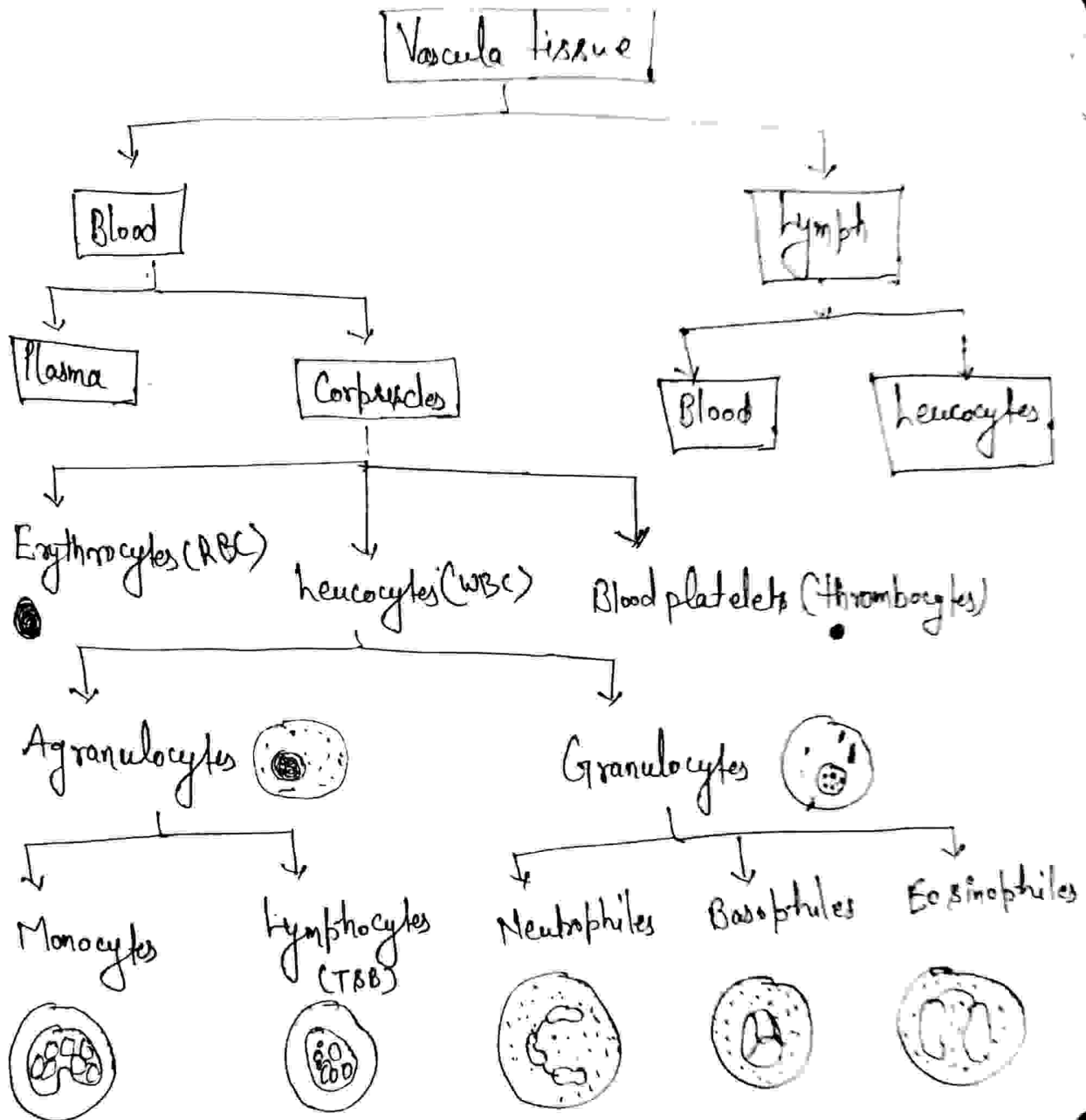
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Haemopoiesis:- The process of blood cell formation is called haemopoiesis. Bone marrow is highly vascularized connective tissue located in bone tissue.

- Blood cells are synthesized mainly in Red bone marrow. Some lymphocytes are produced in lymphoid tissue.
- All blood cells originate from pluripotent stem cells and go through several developmental stages before entering the blood.
- Different types of blood cell follow separate lines of development.
- The process of development of red blood cell from stem cell takes about 7 days and is called erythropoiesis.
- In order to form blood cells, pluripotent stem cells produce two type of stem cells
 - Myeloid Stem Cells.
 - Lymphoid Stem Cells.

• Myeloid stem cell:- Development in Red bone marrow and give rise to red blood cells, platelets, monocytes, neutrophils, Eosinophils & Basophils

Lymphoid stem cell:- Development in red bone marrow but complete it in lymphatic tissue; they give rise to lymphocytes.



~~Range~~ Range: →

- RBCs (4.8 - 5.4 millions)
- WBCs (5,000 - 10,000)
- Platelets (1,50,000 - 4,00,000)

In WBC :- Neutrophils (60-70%)
 Lymphocytes (20-25%)
 Monocytes (3-8%)

Eosinophile :- (2-4%)
 Basophils :- (0.5-1%)

(3)

Cellular Components of blood :- The cellular elements of blood are:

1. Red blood Cells (Erythrocytes)
2. White blood Cells (Leucocytes)
3. Platelets (Thrombocytes)



Red Blood Cells :- (Erythrocytes) :- It contain the oxygen carrying proteins haemoglobin that gives red colour to ~~the~~ Blood.

Count :- 4.5 millions/ μ l in male

4.8 millions/ μ l in female

Shape :- A normal RBCs is a Biconcave disc shaped.

Size :- 7-8 μ m \times thickness 2 μ m.

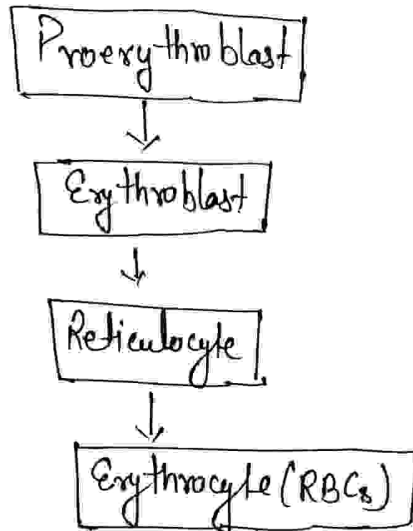
Life Span :- 120 days approx.

- RBCs serve important functions such as transport of O_2 & maintenance of acid base balance.
- They do not have a nucleus. But they have a respiratory pigment called haemoglobin.
- The are synthesised in the bone marrow found at the end of long and short bones.

Erythropoiesis :- Process by which RBCs are formed. In the foetus RBC are formed in the liver, spleen and red bone marrow

• After birth they are formed only in the red bone marrow of sternum ribs, vertebrae etc.

Stages in the Development of RBCs are as follows; -



- ① Proerythroblast:- It is the 1st stage. It is a large cell having a nucleus. It does not have ~~the~~ hemoglobin initially. In the latter stages hemoglobin starts appearing.
- ② Erythroblast / Normoblast:- It is the 2nd stage. It is a smaller cell with degenerated nucleus. But hemoglobin is fully present.
- ③ Reticulocyte:- Develops from normoblast. It contains hemoglobin and reticulum in the cytoplasm.
- ④ Erythrocyte:- Which is fully developed RBC, It does not contain reticulum but contains adequate hemoglobin.

Both vita B₁₂ & folic acid are necessary for the development of RBCs.

Pyrrrole Ring - Sta \rightarrow $\left\{ \begin{matrix} 1 \\ 1 \end{matrix} \right\}$

Hemoglobin :- It is the respiratory pigment of erythrocytes

- The red colour of blood is due to hemoglobin. It contains globin, a protein which is conjugated with heme (hemoglobin = heme + globin)
- Heme molecule contains 4 Pyrrrole rings with iron in the center.
- The hemoglobin content of body is about 15g/100 ml of blood.
- Anemia occurs due to \downarrow in hemoglobin

Functions:- ① Transport of O_2 & CO_2

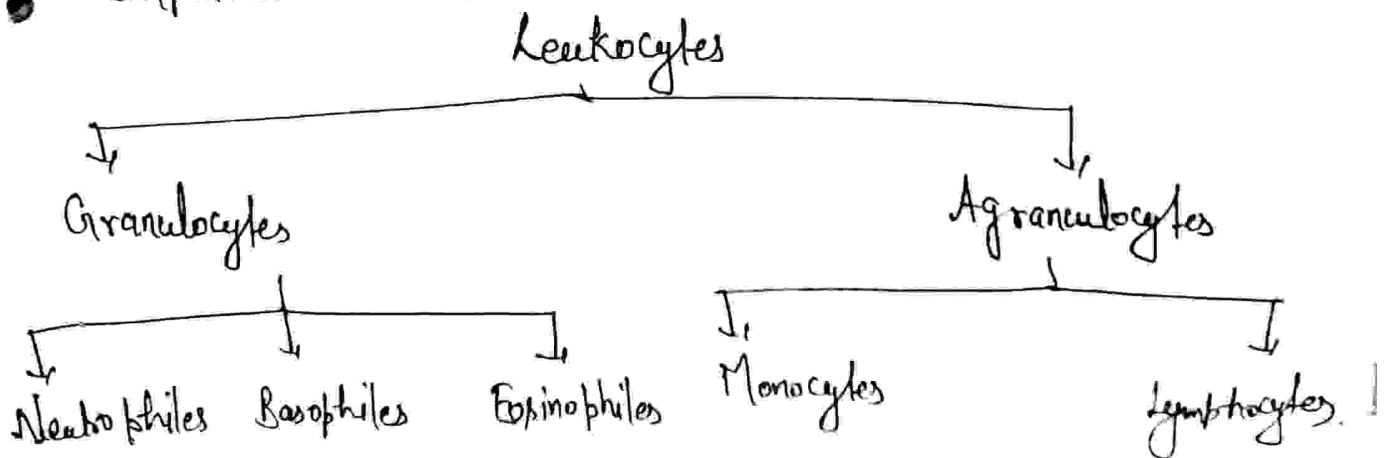
② Maintenance of Acid Base equilibrium.

③ As a source for formation of bilirubin.

Hemolysis:- It is the escape of hemoglobin from RBC in the blood. This is caused by hypotonic condition, certain drugs & toxins.

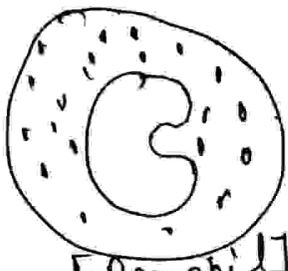
② WBCs (Leukocytes)

- They are colourless cells containing a nucleus.
- They are larger in size than RBCs. Also their number is less as compared to RBCs



① Granulocytes!- WBCs have granules in the cytoplasm, They have nucleus which contains two or more lobes. It is divided into three types!-

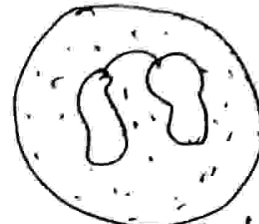
(i) Neutrophils!- (Polymorphs) :- They contain granular cytoplasm which stains with natural dyes. The nucleus may contains 2-5 lobes. Neutrophils occur to the extent of 60-70% of total WBCs.



[Basophil]



[Neutrophils]



[Eosinophils]

(ii) Eosinophils (Acidophils)!- These cells are slightly larger than neutrophils. The granules are coarse & closely packed. These granules take up acid stain. The nucleus contain two lobes. Normal eosinophils count 2-4% of total WBCs.

(iii) Basophils (Mast cells)!- They contain coarse granules as in eosinophils but these granules stain blue with basic dyes. The nucleus is kidney shaped or lobulated. It contains Heparin, Histamine, 5-Hydroxytryptamine. Normal Range - 0.5-1% of total WBCs.

② Agranulocytes; This type of WBCs do not have granules. But they have a single nucleus which is not lobed. It is of two types!-

(a) Lymphocytes!-

(i) Small!- Occur to the extent of 25% of total WBCs. A nucleus occupying almost the whole of the cell, so the cytoplasm is less.

(ii) Large Lymphocytes!- They are larger in size containing more cytoplasm.

Monocytes:- They are largest of WBCs, They occur to the extent of 2-4% of WBCs. They contain an eccentric nucleus which is notched in the inner side. (3)

Functions:-

- Protect against infection. This is done by neutrophils & monocytes which engulf bacteria. This process is called as phagocytosis.
- To aid in the repair of injured tissue
- To produce immune substances which defend against diseases.
- Basophils secrete an anticoagulant substance called Heparin.

(3) Platelets (Thrombocytes)

- These are round oval shaped cell with biconvex surface.
- They are roughly one fourth of the size of RBC.
- Normal platelet count is 2-5 lakh per cumm of blood.
- Platelets do not have nucleus. But cytoplasm contains distinct granules. They are synthesized by megakaryocytes (giant cells) of bone marrow.

Functions:- Thromboplastin liberated from platelets is essential for clotting

- They close minute lesions in the walls of blood vessels
- They aid in body's defence mechanism against bacteria
- They contain histamine & serotonin.
- They contain some antigenic substances also.

Thrombocytopenia:- Condition where there is a ↓ in platelet count.

Body fluids & Blood

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UNIT →

BLOOD IN THE BODY, FLUIDS & CIRCULATION

Blood → A liquid connective tissue in the body that runs through the vessels to act as a medium for the transport of oxygen, nutrient and hormones.

System related blood & Blood, hearts, Blood vessels, lymphatic system.

functions of Blood :-

i) Transport :-

- It transport O_2 to the cells from the lungs and CO_2 from cells to the lungs.
- It transport nutrient from the digestive organs to the cells.
- It transport hormones and enzymes to the target tissue and glands.
- It carries protective substances such as antibodies.
- It carries blood clotting factor.
- It transport waste products from body cells to kidney, lungs, and sweat glands.

ii) Regulation :-

- Blood regulates pH of body through buffers.
- It regulates body temp through the heat absorbing and coolant properties of its water constant.
- It regulates water content of cells due to its osmotic pressure.

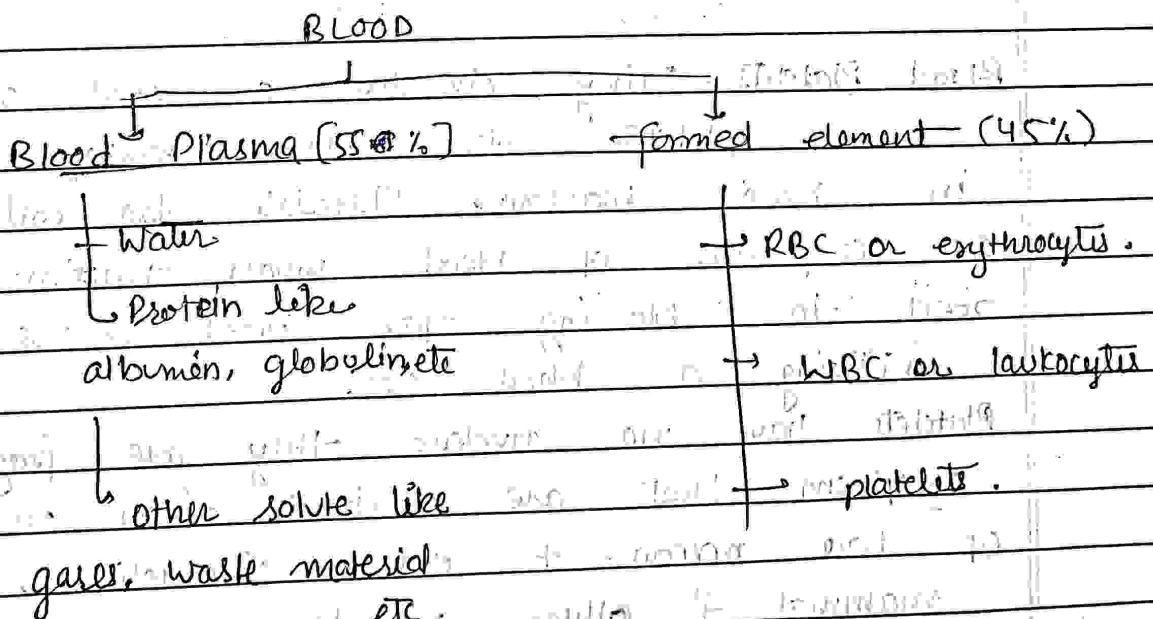
iii) Protection:

- It protects body against blood loss through its blood clotting material.
- It protects body against disease through phagocytosis, white blood cells and antibodies.

★ Physical Characteristics of Blood:

- Blood is denser and more viscous than water and feels slightly sticky.
- The temperature of blood is 38°C (100.4°F), about 1°C higher than oral or rectal body temp.
- It has a slightly alkaline pH ranging from 7.35 to 7.45.
- Blood constitutes about 20% of extracellular fluid (ECF), amounting to 8% of the total body mass.
- The blood volume is 5 to 6 litre (in an average sized adult male) and ~~6~~ to 7 litre in an average sized adult female.

COMPOSITION OF BLOOD:



- Blood Plasma: A liquid portion of blood, works as a solvent, it contains 80% of water. It absorbs and transports.
- Blood consists of 55% blood plasma.
- Blood plasma is ~~compound~~ composed of about 91.5% water and 8.5% solutes.
- The solutes are mainly proteins (7%) & others like gases, nutrients, waste products & electrolytes.

• Formed elements:

There are various types of cells & cell fragments. Blood contains about 45% formed elements. Normally more than 99% of formed elements are cells named for their red colour, RBCs.

RBC

- Production of blood cells is controlled by erythropoietin, a hormone produced by the kidney. RBCs start as immature in bone marrow & after approx. seven days of maturation are released into the bloodstream.

Blood Platelets & Tiny circular or oval colourless

~~platelets~~ also called ~~thrombocytes~~ cells formed in bone marrow. Platelets also called thrombocytes are components of blood whose function is to react to bleeding from blood vessel injury by initiating a blood clot.

Platelets have no nucleus they are fragments of cytoplasm that are derived from megakaryocytes of bone marrow & enter circulation, found in mammals & other animals.

• Composition :-

Blood is an connective tissue & consists of 4 things namely plasma, RBC's, WBC's and platelets.

- Plasma :- Plasma is a liquid also called as fluid matrix. It consists of 3 type of cells which keep floating in it i.e., RBC, WBC and platelets, contain organic substance in dissolved form like Urea, fat, amino acid, Glucose, Hormone, enzyme etc. The protein in plasma include antibodies to assist in body's defence system against disease & infection.

- RBC (Red Blood cells) :- It is also known as erythrocytes. They are disc-shaped cell concave in middle and are visible under a microscope.

RBC carries oxygen from lungs to all cell of body. They have no nucleus and contain pigment called hemoglobin.

- RBC's are produce in spleen & bone marrow and live for about four months.

Life of RBC is about 100-120 days.

function :- Hemoglobin within RBC's transport most of the

- O_2 and part of CO_2 in the blood.

- WBC (White blood cells) :- It is also known as leukocytes.

They fight with infection so protect us from diseases because they eat up germs. It is also

called soldiers of body's defence system. They are round

or irregular, semi-transparent cell containing a nucleus & visible under a microscope.

These are little larger than RBC but are much smaller in number than RBC.

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Some WBC make chemical called antibodies to fight against infection i.e. they provide immunity to fight against infection.

functions

WBC act as body defence system there are several varieties of WBC performing specific attack the invading bacteria and engulf function such as neutrophil.

Neutrophil :- It attack the invading bacteria and engulf them.
Lymphocytes :- It produces antibodies which protect body against antigen and thus provide immunity against infection.

Basophile :- Secrete anticoagulant called heparin which inhibit prevent clot within blood cells.

Eosinophils & monocytes :- It also assist in defence mechanism of body by becoming against germs.

Hemopoiesis :-

It is the formation of blood cells from hemopoietic stain as in Red bone marrow.

ESR [Erythrocytes Sedimentation Rate] :-

The rate at which erythrocyte settle down to formed a sedimentation when allow to stand in a test tube is called an erythrocytes sedimentation rate.

The rate is fixed for normal blood [0.10 ml in men] and [0.20 ml in women] in first hours.

• RBCs amount :- 4.8 million per/ml (women)

5.4 million per/ml (man)

• WBCs amount :- 5-10 thousand per/ml

* ABO Blood Group

	Group A	Group B	Group AB	Group O
• RBC type	A	B	AB	O
• Antibodies in plasma	B	A	—	Antibodies - A Antibodies - B
• Antigen in RBC	A	B	Antigen - A Antigen - B	—

Blood group → Receive

AB → A, B, AB, O (Universal recipient)

B → B, O

A → A, O

O → O (Universal donor)

The ABO blood group is based on two glycolipid antigens called A and B. People whose RBCs display only antigen A have type A blood and those having only antigen B are of type B.

• **Transfusion** - A transfusion is the transfer of whole blood or blood components into the blood stream of a person to alleviate anemia, to increase blood volume, or to improve immunity.

In an incompatible blood transfusion, antibodies in the recipient's plasma bind to the antigen on the donated RBCs, which causes agglutination (clumping) of the RBCs.

• ABO and Rh blood group are generally determined and based on antigen antibody response.

• In ABO blood group, the presence or absence of A and B antigens on the surface of RBCs determine blood type.

• In the Rh system, presence (Rh⁺) or absence (Rh⁻) of Rh antigen determines the blood type.

• Hemolytic disease of the newborn (HDN) can occur when an Rh⁻ mother is pregnant with an Rh⁺ fetus.

• Before blood is transfused, a recipient's blood is typed and then either cross matched to potential

donor blood or screened for the presence of antibodies.

Hemostasis Mechanism of Coagulation

It is the mechanism of blood clotting.

~~Extrinsic Pathway~~ ~~Intrinsic Pathway~~

It is a sequence of responses that stop bleeding. These mechanisms reduce blood loss when blood vessels are damaged or ruptured: vascular ^(spasm) system, platelet plug formation and blood clotting. When successful, hemostasis prevents hemorrhage.

i) Vascular spasm - In this, the smooth muscle of a blood vessel wall contracts which slows blood loss due to release activated platelets.

ii) Platelet plug

- platelet adhesion → platelets stick to damaged blood vessels.
- Platelet release reaction
- Platelet aggregation

iii) Blood clotting - A clot is a network of insoluble protein fibres (fibrin) in which formed element of blood are trapped. Clotting involves several substances known as clotting factors [coagulins]. These factors include Ca^{2+} ion, several inactive enzymes (synthesized by liver cells and release into the bloodstream), and various molecules associated with platelets or released by damaged tissue.

Mechanism - Blood clotting involves a cascade of reactions that may be divided into three stages.

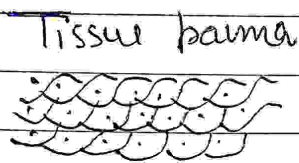
iii) formation of prothrombinase - Two pathways, called the extrinsic pathway and the intrinsic pathway, lead to the formation of prothrombinase.

ii) Conversion of Prothrombin into thrombin - It is a common pathway, it catalyzed by Prothrombinase and Ca^{2+} .

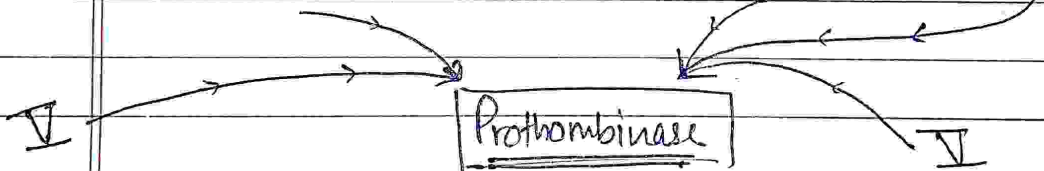
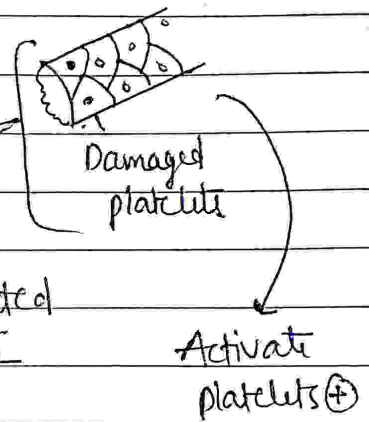
iii) Conversion of fibrinogen into fibrin - Thrombin, in the presence of Ca^{2+} , convert soluble fibrinogen into insoluble fibrin threads.

DL _____ B+
Pg. _____

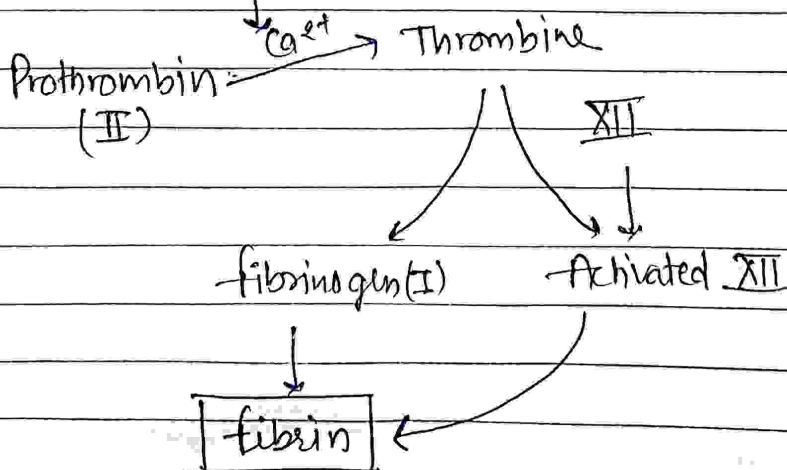
a) Extrinsic pathway



b) Intrinsic pathway



c) Common pathway



• where fibrin is a insoluble protein fibres, which form clotting.

Unit - III

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LYMPHATIC SYSTEM

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- The network of vessels through which lymph drains from the tissue into blood.
- Lymphatic system is a network of organs, lymph nodes, lymph ducts & lymph vessels that makes a move from tissue of blood stream.
- Lymphatic vessels carry lipids & lipid soluble vitamins absorbed by the gastrointestinal tract to blood.

Parts of lymphatic system

• Lymph

• Lymphatic Vessels

— lymph trunks & ducts

— Thoracic ducts (left lymphatic duct)

— Right lymphatic duct

• Lymphatic tissue

— lymph nodes

— tonsils

— spleen

— thymus gland

Lymph → The excess interstitial fluid which drains into the lymphatic capillaries is called as lymph.

- Lymph is a colourless fluid which consists of blood plasma & lymphocytes but not platelets. It is alkaline in reaction. Compared to plasma it contains a high amount of fat.

Chemical composition →

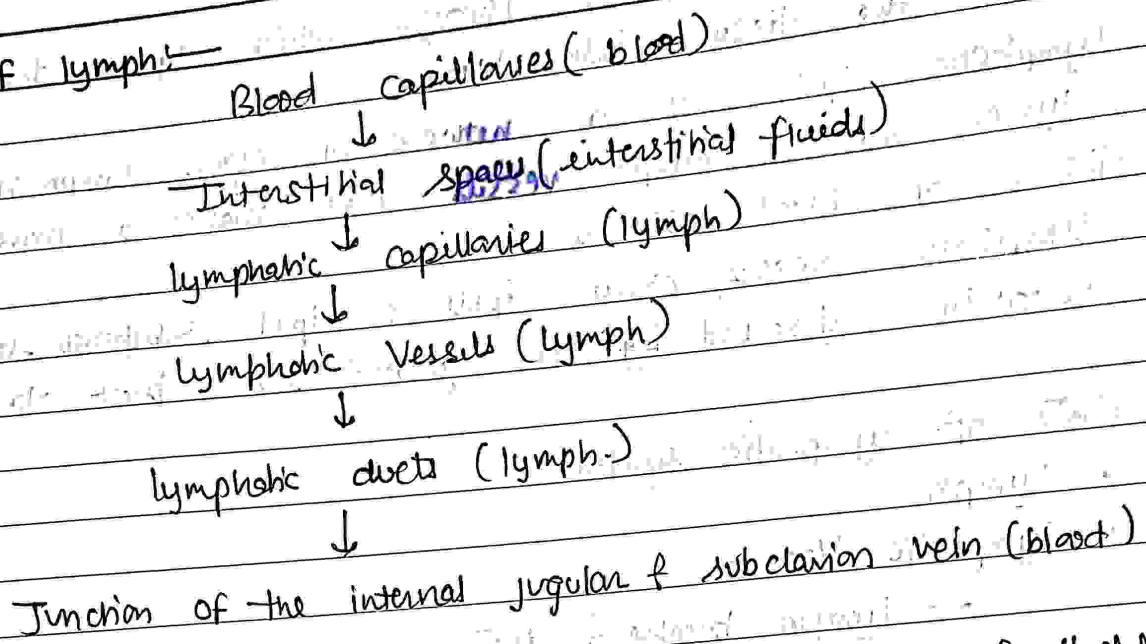
✓ Proteins (g/100ml): 2.6

✓ chloride (m. eq/litre): 116

✓ Calcium (m. eq/litre): 46

✓ Urea (mg/100ml): 23.5

flow of lymph:—



- lymphatic flow regulated by means of movement of skeletal muscles and through the breathing movement.

↓

Movement compresses the lymphatic vessels and forces the lymph flow towards the subclavian veins.

↓

lymphatic vessels contain one way valve that prevent back flow of lymph.

lymphatic vessels :-

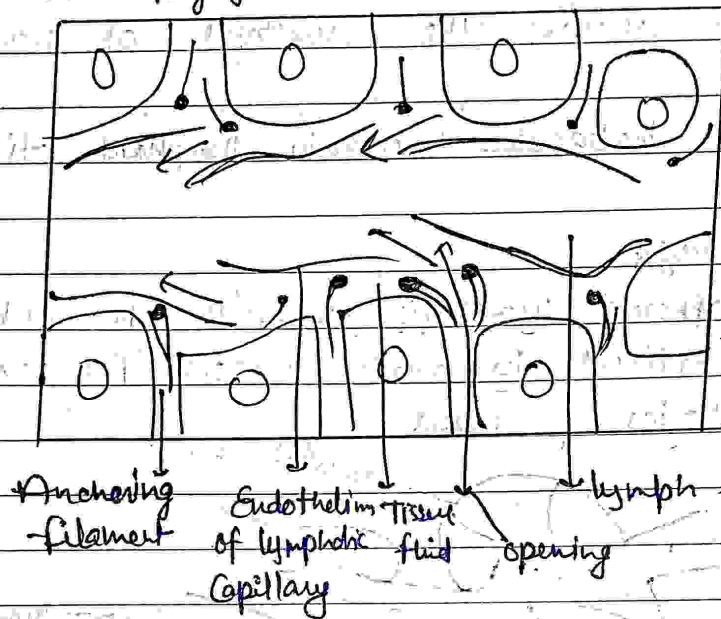
These are tiny thin walled vessels, closed at one end.

- The wall of lymphatic capillaries is made up of endothelium.
- Main purpose is to drain excess interstitial fluid from around to cell to venous.
- A lacteal is a lymphatic capillary present in mucosa of S.I.
- It absorbed dietary fats & lipid soluble vitamins from the S.I.
- It absorbed diet a special type of lymph known as chyle, is produced in the

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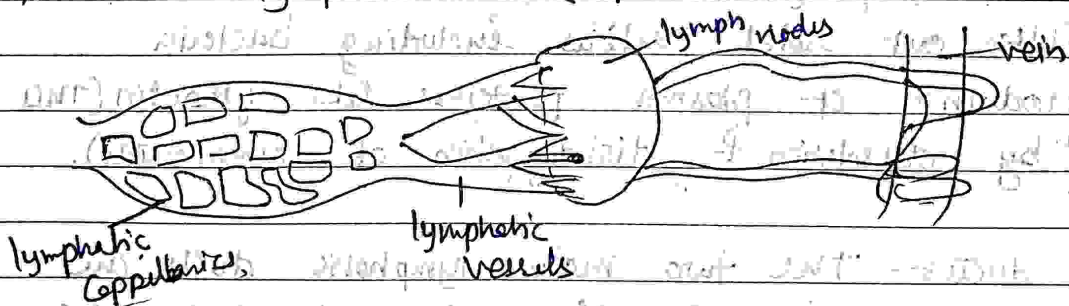
digestive system as lymph absorbs triglycerides from the intestinal villi.

- The chyle has a milky white colouration due to the presence of triglycerides.



Lymphatic capillaries →

- lymphatic capillaries combine together to form lymphatic vessels. These are thin walled structures that carry lymph. These capillaries are composed of a single layer of cells.
- A lymph vessel pushes lymph from lymph capillaries to the lymphatic trunk & ducts.



Lymph nodes → These are small oval & bean shaped glands. They are present in the course of lymphatic vessels.

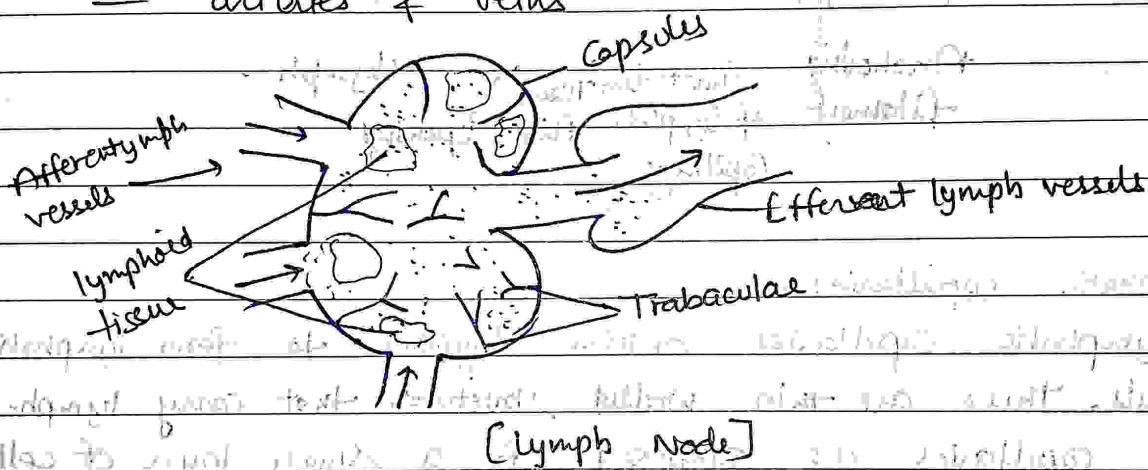
- Lymph nodes are usually distributed in groups.
- The main groups of glands are present in the Neck, Axilla, thorax abdomen & groin.

Structure →

- Concave border called hilum
- Outer dense fibrous tissue called capsule
- Capsules give rise to fibrous bands called trabeculae
the trabeculae divides the substance of nodes into irregular spaces.
- Space b/w trabeculae contain lymphoid tissue

Lymph pass through

- An afferent lymphatic vessels (for entry)
- An efferent lymphatic vessel (for exit)
- arteries & veins

function →

- Produce lymphocytes
- filter out solid particles including bacteria
- production of plasma proteins like globulin (this is done by dissolution & disintegration of lymphocytes).

Lymphatic ducts — The two main lymphatic ducts are thoracic duct & Right lymphatic ducts. After filtration by the lymph nodes the lymph is emptied by lymphatic vessels into these two lymphatic ducts.

• clear & smooth

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• Thoracic ducts → The larger layer of lymphatic ducts, it drains lymph from the pelvis, abdomen, left half of the thorax, left arm, head & neck, it pours its contents into the left subclavian vein.

Right lymphatic duct :- Small dilated lymph vessels about 1cm long it drains lymph from the right half of thorax, right arm & head & neck. It empties into the vein at the right side of the root of the neck.

Spleen → It is dark purple colored lymphoid structure. It is highly vascular & bean shaped & measure about 12cm in length. It is present in the left side of the abdominal cavity below the diaphragm.

Structure → • Outer layer covering of fibroelastic tissue called capsule

- Trabeculae arise from the capsule & pass into the substance of the gland.
- The space b/w trabeculae contains the splenic tissue the tissue contains the lymphoid tissue called as malphigian corpuscles.
- Spleen is supplied by splenic artery & drained by splenic vein.

Functions → • Produces all type of blood cell during foetal life.

- RBCs are destroyed in spleen
- Spleen serves as a reservoir of blood
- It also produce Abs.

Tonsils → - Collection of lymphoid tissue. There are two tonsils one each lies on each sides of pharynx b/w the pillars of fauces tonsils are supplied with blood & lymphatic vessels.

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Surface is covered with blood & lymphatic vessels.
Mucous membrane which is studded with crypts.
Lymphocytes present in fluid on the surface
of villi also in the crypts.